an inch in diameter and only 6 inches high. The writer was looking for a tough stout specimen 8 inches high and $1\frac{1}{3}$ inch thick.

Gray had not noticed that at one of the tapering and rounded ends there was a contracted opening with well-defined margins that could easily be stretched several millimetres.

The writer failed to find the axial stem of sea-weed; but there can hardly be any doubt that it has existed, and possibly it still exists, but there is no need to mutilate the specimen to find it.

A dissection of one of the polyps showed four folds in the branchial sac, and gonads only on the right side of the body. (The writer only found two gonads, but one may have been lost in removing the ascidiozooid from the very tough test.) Accordingly, Hartmeyer's identification of his specimens collected near Fremantle is fully confirmed by comparison with the recovered type.

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## L.—*On the Anatomy of some new Species of* Drawida.

By C. R. Narayana Rao, M.A., University of Mysore, Bangalore.

[Plates XV.–XVIII.]

The adult anatomy of this genus of Oligochæte worms is now fairly well established, especially by the investigations of authors like Beddard, Benham, Bourne, Michaelsen, Perrier, Rosa, and Stephenson. The present communication deals with certain glands associated with the reproductive apparatus of some new species of *Drawida* not hitherto recorded so far as I am aware. The material at my disposal has been a large collection of well-preserved worms collected towards the middle of 1918 in the rain-forests of Coorg, at elevations ranging from 2500 feet to 4000 feet. I do not propose to add any remarks on the known species contained in my collection, but will select for discussion the forms hitherto undescribed. I have received from Dr. Stephenson and Dr. Michaelsen, copies of their excellent papers relating chiefly to those forms occurring in Ceylon and the Indian Empire, and my thanks are due to them and also to Dr. N. Annandale, who courteously permitted me in June 1919 to examine the named collection of the Oligochæte worms belonging to the Zoological Survey of India.

Dr. Michaelsen, in his memoir on the Oligochæta of the Indian Empire and Ceylon, remarks that S. India and Ceylon are the proper home of the genus *Drawida*, and perhaps the whole forest-clad elevated portion of western India and Ceylon is its principal original habitat. In the months of March and April, before the heavy showers descend, the heat in this area is intolerable, and several species of *Drawida*, perhaps meeting a rock or some other impenetrable surface while burrowing deep down to escape the dry heat, come out and perish in numbers all along the jungle foot-paths. The immense thickening of the anterior body-wall and the septa in all the species described in this paper, and the provision for the storage of water in the anterior nephridia (salivary glands) and the appendages of the alimentary canal, must be closely correlated with the conditions of life to which they are exposed. When a specimen is put on a sheet of blotting-paper, it goes on depositing drops of fluid exuding from the mouth as it explores, and a few drops of such a fluid under the microscope reveal cellular debris and corpuscles of the cœlomic fluid. The mode of transmission of water from one segment to the other must be partly by percolation through septal crevices and partly by rapid cellular absorption, aided by the contraction of the specially large transverse muscles in the genital and anterior somites. The conspicuous development of these circular muscles and the enteric appendages are purely a secondary adaptation, and may vary in individuals of the same species differently situated.

### *Drawida somavarpatana*, sp. n.

*External Characters.*—Length of spirit-specimens, 80 to 95 mm.; fully stretched live ones, 100 to 105 mm.; maximum diameter in the preclitellar region, 5 mm.; at about middle of body, 3·5 to 4 mm. Number of segments 80 to 90: no secondary annulations.

Colour, deep blue or almost black in the living condition. Spirit-specimens grey with blue on the anterior somites.

Prostomium prolobous; dorsal pores absent. Setæ very small and closely paired; *aa* equals *bc*; *d* is on the mid-lateral line of body in the postclitellar part and below this line anteriorly.

Nephridiopores large, placed on seta-line *d*; bases of setæ chiefly the ventral series surrounded by whitish sensory papillæ. The skin all along the line of nephridial apertures has a glandular thickening.

Clitellum well marked over 4½ segments (10, 11, 12, 13, and 14/2). In the living specimens the grey of the clitellum forms a striking contrast to the general blue background of the body; a very deeply marked glandular fold on the sides of segments 10 and 11 forming a sort of copulatory bracket round the genital orifices. Between these folds in the median line are more or less clearly defined oval elevated glandular swellings on somites 10, 11, and 12.

The genital area varies markedly in individuals of different degrees of sexual maturity. In the fully mature forms the region between the male apertures, *i. e.* the ventral part of somites 10 and 11, may be completely hollowed out and dark, which is occupied by glandular swellings in slightly less mature forms. It is noticed that in several large individuals the clitellar lateral folds on segments 10 and 11 are either feebly indicated or are not developed. It is in the fully mature forms that the clitellum itself extends over half of the segment 14, while in others only four segments are affected. The other grooves and depressions present on the ventral surface of the genital area must be due to the disproportionate clitellar thickenings.

The male aperture is a large transverse slit between segments 10 and 11, situated on spherical tumid elevations in the furrow on or slightly external to seta-line *b*. Female apertures between segments 11 and 12, inconspicuous, internal to seta-line *a*. The spermathecal orifice in furrow 7/8, not easily visible, in line with the male openings.

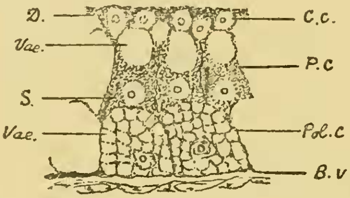
*Internal Anatomy.*—There are no septa between somites 1 and 2, and 2 and 3. Those between 3 and 4, 4 and 5 are fairly, and others (5 and 6, 6 and 7, 7 and 8, 8 and 9) considerably thick. In some specimens the septa 6/7, 7/8, and 8/9 are only as thick as the anterior ones.

*The Muscular System.*—The internal longitudinal muscles are tough, and are far more powerfully developed in the anterior somites, where they are iridescent. In somites 9 to 12 are laid additional innermost transverse bands of muscles such as are described in *D. robusta*, subsp. *indica* (Benham).

The œsophagus is a thin-walled narrow tube extending up to somite 13. Gizzards from 3 to 5 with softer annuli between them are placed in somites 14 to 21. The first gizzard is usually small and thin-walled. The alimentary canal is thin-walled, and bears dorsally finger-shaped appendages which commence from behind the last gizzard. These glandular structures, which we may term "enteric appendages," in the same position as the "lymph glands" of other worms like *Pheretima*, occur in most species of *Drawida* examined and described in this paper. Commencing from behind the last gizzard, there are a pair of these finger-shaped organs occurring in each segment in various degrees of development. A reference to these structures has rarely been made by previous authors, who have described about forty and odd species belonging to this genus. The mode of development of these organs is best studied in young worms, such as those of *D. paradoxa*, in which they occur in the middle and hinder portion of the intestine in an incipient stage. The dorsal muscle-fibres (Pl. XVI. fig. 4) of the alimentary canal, at the points where the glands are developing, are laid or become disposed like the ribs of a fan, and are comparatively shorter than the neighbouring fibres, which are certainly longer and are circularly disposed. In the middle of each of the former set of fibres a swelling takes place, due to the accumulation of lymph and lymph (cœlomic) corpuscles. At the point where these specialised muscle-fibres, which ultimately change their muscular character, converge on the inner border towards the dorsal vessel, there is a dense heaping up of cells proliferating from the peritoneum. From this source, these rapidly multiplying cells move outwards across the metamorphosing muscle-fibres, becoming at the same time incorporated with the cœlomocytes. The number of muscle-fibres affected at the beginning may be between 24 and 36, out of which about 6 to 12 may reach the final stages of glandular development, while the others are detectable in a state of arrested growth. A fully formed glandular process thus derived from a muscle-fibre may attain a size nearly over fifty times that of the latter. I could discover no peritoneal covering on the digitate processes or on the basal lobe, even in sectional preparations, and there is no other connection between these stuctures and the septa beyond a few muscle-fibres. Both morphologically and perhaps physiologically, too, these enteric appendages of the species of *Drawida* described here would appear to be distinct from the "lymph glands" of Schneider.

It is noteworthy that these structures are best developed in forms taken in places rather dry and exposed. Each of these appendages, looking white and disposed in the form of tubules, is attached to the dorsal vessel partly by its own connective tissue, but mainly by an arterial twig on either side. This is the principal source of blood-supply to them, and histologically they are mesoblastic in origin. When an entire appendage is cleared by acetic acid, and examined microscopically under the high power, more than two kinds of cells can be discovered. The marginal portions of the processes are fringed by fairly large club-shaped cells, not unlike the solenocytes of polychæte worms with perhaps similar functions. Broken and degenerate setæ are also found obviously in the process of elimination through the alimentary canal. The basal parts are occupied by large pyramidal and polygonal cells, with either a single large vacuole as in the former or numerous smaller vacuoles as in the latter case. The tapering portion of the pyramidal cells, which is also the region of vacuoles, extends into the peripheral portion of the appendage, while a fairly rich network of capillaries surrounds the basal tissue elements. The mode of elimination of setæ must be through the

Text-fig. 1.




A portion of the enteric appendage mounted in glycerine.

*C.c.*, club-shaped cells; *S.*, broken setæ; *P.c.*, pyramidal cells; *Pol.c.*, polygonal cells; *B.v.*, blood-vessel; *Vac.*, vacuoles; *D.*, organic debris.

blood-vessels entering the alimentary canal, while the debris of waste matter also found in the appendages must be carried to the nephridia by the blood-vessels to be discharged outside. But their main function is probably to act as water-storing organs. When fresh specimens are examined, the large vacuoles present in the basal cells are seen to contain quantities of water, apparently imbibed in the heavy wet weather to be utilised during periods of more or less prolonged drought. These appendages are not, however, the only water-conserving organs. The anterior nephridia (Peptonephridia) in somites 3, 4, 5, which open into the pharynx and accordingly are deemed salivary glands, differ structurally in certain particulars from the segmental renal organs. In the main lobes of the former nephridia, in addition to the non-ciliated glandular wide tubes, we find other similar wide canals which follow a tortuous course, and the narrow ciliated tubules are considerably wider than in the nephridia of the hinder somites. The whole system of draining tubes is connected by fairly wide vertical canals and is a device for the rapid absorption and diffusion of fluids into the pharynx. It is doubtful whether, at least in this genus and others affecting the hotter countries, the term salivary gland used in certain text-books for the description of these nephridia, correctly denotes their function, which at any rate cannot be peptic. At least in the several species of *Drawida* which I have observed and examined, these structures would appear to be associated more with the function of collecting and discharging water through the mouth, both while feeding and burrowing, than with any digestive function.

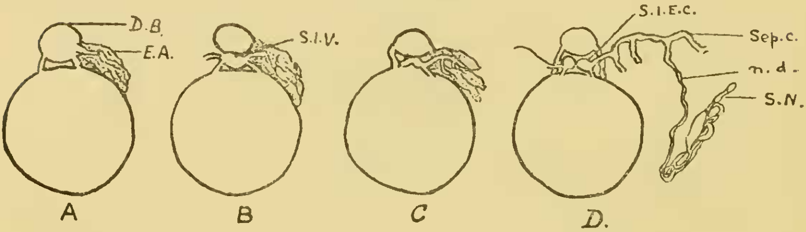
In the species of *D. elegans* and *D. modesta* described below, the intestinal appendages, chiefly in the posterior somites, are greatly enlarged, while the blood-vessels going to them on either side, are also correspondingly elongated. Usually a supra-intestinal (? typhlosolar) vessel is found in these forms, and the appendages in such cases have a double connection with the vessels—one with the dorsal and the other with the supra-intestinal vessel. The enteric vessel is derived in an arbitrary manner, either directly from the longitudinal vessels or from the appendicular branch.

At the same time, these appendages in the several somites are more or less confined to one border of the branch-vessel, and developed in the form of separate lobes. It is hypothetically possible to derive the recently described septal nephridia of *Pheretima posthuma* from the enteric appendages of *Drawida*, and the only fact available at present in favour of such a hypothesis is the histological resemblance between the two structures. The excretory water-conserving organs of *Drawida* are certainly mesoblastic in origin, as is testified to by their cellular structure, and for a similar reason the septal nephridia also are of the same origin *. Moreover, there is not any histological difference between the septal organs of *Pheretima* and the meso-nephridia of genera like *Acanthodrilus*, *Perichæta*, *Megascolex*, *Notoscolex*, and other forms which I have investigated. The process of the evolution of septal nephridia may be illustrated as shown in text-fig. 2. I am disposed to believe that the suggestion of Dr. Woodland that the system of enteronephric tubules

* 1919. N. F. Woodland, Q. J. M. Sci. n. s. vol. lxiv. part 1, p. 101. "But it seems to be evident that the septal nephridia of *Pheretima* certainly cannot be developed from ectoderm, but must be mesodermal in origin, since we can hardly suppose they are endodermal outgrowths.

is a means of conserving water in tropical earthworms like *Pheretima* is the more correct interpretation of their function; for if these structures were concerned in the elimination of waste through the gut, as is presumed to be their function, then the chances of these waste particles being repicked up by the chloragogenic or yellow cells of the alimentary epithelium will have to be accounted for. The yellow cells are present in the gut-wall and typhlosole of the *Pheretima* quite as numerously as in the other examples of earthworms like *Perichæta* or *Megascolex*. More than this, the volume of the toxic products entering that part of the gut where the digestion and absorption of food take place must be so large, judging from the number of septal nephridia in *Pheretima*, that it is certainly doubtful whether these digestive processes occur without the ferments being

Text-fig. 2.




**A** shows the relation of dorsal blood-vessel (*D.B.*) and the appendage (*E.A.*). In **B** the relation of the supra-intestinal vessel (*S.I.V.*) and the appendage is shown. **C, D** are hypothetically derived from **B**. *n.d.*, nephridial duct; *S.N.*, septal nephridia; *Sep.c.*, septal canal; *S.I.E.C.*, supra-intestinal excretory canal.

destroyed. On these physiological bases alone, it may not be quite correct to ascribe to these "enteronephric" systems an excretory function. If, in addition to the histological affinity between the enteric appendages of *Drawida* and the enteronephridia of *Pheretima*, embryological evidence also is forthcoming, then there can be no doubt about their being an adaptation for the conservation of water.

*Vascular System*.—The last hearts are in segment 9 and the most anterior ones in segment 5. The dorsal vessel is thickest over the region of gizzards and is connected with the lateral longitudinal vessels by secondary vascular commissures in somites 9, 8, and 6. The lateral longitudinal vessels, whenever present in this species, rarely extend beyond somite 20. A supra-intestinal occasionally and a subneural vessel never present. Both the dorsal and ventral vessels are full of muscular fibres and the phenomenon of the walls of the heart becoming opaque on pouring spirit on freshly opened specimens, observed in *D. grandis*, Bourne, is shared by the dorsal vessel over the gizzards in this species and in *D. elegans*. The degree of development of vasa vasorum in the walls of the heart diminishes as we go forward and it is also present in the walls of the ventral vessel, which picks up opacity under the spirit, though to a less extent. I have been unable to discover any valves in the course of the principal vessels, and the internal endothelial layer in the dorsal and ventral trunks may be thrown into folds simulating a valve-like structure in the regions anterior to somites 10, where the mesenteries are thickest. It is also in this part of the body that the powerful muscular contractions, while burrowing or otherwise, are likely to reverse the course of the blood-flow, and hence the need for valve-like structures. The lumen of the arterial twigs going to the enteric appendages is partially divided longitudinally by a ridge-like elevation of the internal lining. This partial division perhaps represents an incipient stage in the morphological differentiation of the vessel into afferent and efferent ducts. The only other region where I have noticed a valve-like fold is the point where the enteric twigs are given off either directly from the longitudinal dorsal vessels or from the appendicular branches. The valves are simple folds of endothelium pointing towards the blood-flow. The lateral longitudinal vessel supplies branches to the anterior nephridia and all the reproductive organs and their associated glands. From the ventral vessel are derived branches for the nervous system, the body-wall, and the ventral walls of the intestine and the nephridia.

*Nephridia.*—I have only to add here that the vesicle described as occurring in *D. grandis*, Bourne, is not present in this and other species, except *D. paradoxa*, described in this paper, and the narrow ciliated tubules form complicated loops in the periphery of the lobes, which, however, can be easily made out from the plexuses of blood-capillaries. The vesicles in these species bear the same microscopic structure as the lobes, hence they are described as being absent as such. The glandular part is disposed in distinctive lobes, the enteric lobe lying on the sides of the intestine, the sub-enteric below the intestine, and the parietal projecting into the sides of the body-cavity. In the species of *Drawida* described in this paper and others * I have examined, I have noticed that the preseptal funnel (Pl. XVI. fig. 5 *a*) is slightly different in structure from that of *D. grandis*. The number of marginal cells is about 10, rarely more; the drain-pipe or centrifugal cells are absent. Their place is taken by a secondary funnel, placed at the bottom of the larger anterior one. This secondary funnel is composed of more or less cylindrical cells, placed transversely to the axis of the cavity of the funnel-tube. The cell-boundaries are not evident even in clarified preparations, and, judging from the number of nuclei which are placed more towards the inner border of the funnel, the cells themselves cannot be more than ten. Each cell is provided with a few stiff cilia, somewhat bent twice, stouter and shorter than those of the marginal cells. There is a distinct flange or outer rim round this smaller funnel, which, like the cells themselves, is full of granular cytoplasm. The funnel-tube is ciliated and has a tunic of cœlomic epithelium.

*Reproductive System.*—The ampullæ of the spermathecæ are fairly large spherical vesicles, lying dorsally, closely pressed against the dorsal vessel. Frequently they nestle in pouch-like excavations on the posterior face of septum 7/8, with an envelope of cœlomic epithelium. When rectified spirit is poured on freshly opened specimens, this sac changes its milk-white appearance into a pale yellow, and at the same time the outer epithelial covering becomes transparent. The duct is thin, much soiled, in its first course over the septum 7/8, and then becomes a fairly long wavy tube, which pierces the septum where it is inserted in the body-wall. From either end of the muscular atrial chamber arise two atrial diverticula † placed in segments 7 and 8. Each atrial or copulatory sac, slightly pinkish with a strong muscular shimmer, is a cylindrical long papilla, somewhat curved, and does not come into view till pulled out from below the œsophagus. In the fully mature worms the diverticula of one side meet their fellow of the opposite side in the mid-dorsal line.

Dr. Michaelsen, in his memoir on the Oligochæta of the Indian Empire and Ceylon (pp. 136–139), discusses, after a microscopical study of the ampulla and the tubular diverticula of the atrium of *Moniligaster perrieri*, the morphological

* *D. pellucida*, Bourne, *D. chlorina*, Bourne, *D. ghatensis*, Mich., and *D. brunnea*, Stephen.

† Such atrial sacs have been recorded in *D. robusta* subsp. *ophidioides*, *D. robusta* subsp. *indica*, *D. minuta*, and *D. shankarai*. In *ophidioides* the pouches are of unequal size.

and functional significance of the different parts of the spermathecal apparatus of Moniligastridæ, and finally attempts to homologise them with those of the family Megascolicidæ. He sets forth his conclusion in the following terms:—"There can be doubt that the pear-shaped, long-stalked pouch in the seventh segment of the *Moniligaster perrieri*," as well as of all other Moniligastridæ, corresponds functionally with the diverticula of the Megascolecid spermatheca, being the magazine of sperm-masses received in the copulatory act. The atrial cavity, on the other hand, may act as a copulatory pouch, corresponding functionally with the muscular duct of the main pouch of the Megascolecid spermatheca, whilst in some species of *Moniligaster* a secretory function is added, being confined to special organs—the glandular branched tubes only in *Moniligaster*." It would require an examination of the spermathecal apparatus of almost every genus of the two families before one can confirm or disprove the view of Dr. Michaelsen. I have microscopically investigated the teased preparations and sections of every part of the spermatheca of the following species of *Drawida*—*D. pellucida*, *D. cholorina*, *D. brunnea*, and *D. ghatensis*, and all the five species described in this paper, which were all sexually mature,—and the results obtained do not confirm the view that the spermathecal atrial organs of the two foregoing families are functionally different, though homologous. First, as regards the ampulla, I must mention that in teased preparations and sections the cavity was found filled with a mucilaginous matter in all the species *, in which no sperms in any stage of development could be detected. This contained substance is easily dissolved by alcohol. In point of microscopic structure the ampulla is uniform in all the species, comprising an internal lining of large columnar glandular cells, which, on clearing by alcohol, shows in teased and sectional preparations granular cytoplasm heavily loaded with mucin and staining deeply (methylin-blue). The nucleus is large, and placed at the middle of the cells. The cavity of the ampulla is not uniform, being narrower at the end where the duct leads off. The glandular layer is invested by a muscular coat, with the fibres circularly disposed, and between it and the outer membranous covering in the cleared preparations and sections is a space filled with a deeply staining granular matter and a

* Dr. Stephenson (Rec. Ind. Mus. 1917, vol. xiii. p. 365), in his description of *D. kanarensis*, mentions that the spermathecal ampullæ "were filled with a shining white opaque mass, doubtless spermatozoa."

few corpuscles. The cells of the external covering are irregular in outline, and the cytoplasm is only sparsely granular, but mostly clear. This outer epithelium becomes membranous when the cell-layers are numerous, and a few connective-tissue fibres become incorporated into the structure. The ducts also were empty in all the species, and the epithelium of these tubes is composed of a lining of non-ciliated cubical cells, with granular cytoplasm and a centrally situated nucleus. The shimmer often noticeable in the ducts is due to the muscle-fibres, which are circularly disposed, rarely a few longitudinal fibres being present, and held together between the internal lining and the excessively thin external membrane (Pl. XVII. fig. 10 *a*).

In the teased preparations of the atrium and the atrial pouches of these species (Pl. XVIII. figs. 10 *h*, 10 *i*), I could discover nothing, except in one individual out of four (*D. somavarpatana* subjected for examination), in which well-developed sperms were found in a mucilaginous base which clogged both the pouches. Dr. Michaelsen found, in his preparations of the ampulla and the atrial appendices of *Moniligaster*, fibrous and granular masses which he identified respectively as sperms and glandular secretions. He next proceeds to establish the functional differences between the ampulla and the copulatory vesicles of the two families Megascolecidæ and Moniligastridæ. From the observation I have recorded above, *i. e.*, that the copulatory appendices were full of sperms in one individual of *D. somavarpatana* and from histological considerations of the ampulla and the diverticula, it is quite possible to reach the opposite conclusion. In *D. ghatensis* the cavity of the atrial pouch is a trigonal chamber; in *D. somavarpatana* it is irregularly divided up into very minute recesses; in *D. elegans* it is a wide chamber, disposed in a spiral; in *D. brunnea* its surface bears a number of annular ridges; in *D. chlorina* the cavity is flask-shaped, and it is simply wide in *D. pellucida*, *D. modesta*, *D. scandens*, and *D. paradoxa*. In all these species the epithelial lining near the ectal ends of the pouches is composed of short cubical cells full of granular cytoplasm and a large nucleus, while in the ental end the cells tend to become syncytial and the cytoplasm is present only very poorly (Pl. XVIII. figs. 10 *f*, 10 *g*). The cell-walls have a strong tendency to become cornified and look like those of the epidermal layer. The muscle-fibres are circularly disposed in a thick layer, and the outer tunic in *D. somavarpatana* is distinctly a thin cuticular layer with little cellular structure. The main fact

I wish to point out here is that the structure of the copulary vesicles in the species of *Drawida* examined enables them to act as magazines of sperms received during copulation and for expelling them for fertilisation later. On hypothetical grounds, too, it is rather difficult to conceive the sperms working their way up all along the most tortuous course of the spermathecal duct, to be housed temporarily in ampulla, and to be returned through the same passage. On examining the material in my possession, I should not hesitate to adopt the view that the ampulla of *Drawida*, like that of the family Megascolicidæ, has a secretory function, while the atrium and its diverticula act as storing organs of sperms, besides aiding in copulation.

*Testes and Sperm-sacs.*—The most important feature of the male reproductive organs of this species to which I should call attention is the occurrence of two pairs of sperm-sacs, a fact not hitherto noticed in any of the numerous species already described. The first pair are very large, yellowish, massive, irregularly subspherical bodies suspended by the septum 8/9 (Pl. XV. fig. 3 *a*). They usually occupy segments 9, 10, 11, and 12, and are never constricted by the septal walls, which, however, are extremely thin in these somites. Frequently they leave their proper position and descend backwards up to segment 18, and wherever placed they repose on the œsophagus and are connected to the septum 8/9 by the drawn-out tubular extension of the wall of the mesentery, and in the succeeding segments they are invested with septal peritoneal outpushings. In somite 9 the œsophagus and other organs are contained in the cavity between the double wall of the thin septum 8/9, and this cavity of the mesenterial sac is continuous all round them. Each of the posterior or second pair of sperm-sacs is really a double, white, tubular vesicle with a velvety appearance. They lie in somite 10, having very early in development detached themselves from the septum 9/10. They are bent in the form of a query-mark, and usually lie hidden below the œsophagus, occupying segments 9 and 10. In one form, which has developed clitellum over 4½ segments, they are very long, and extend as far behind as segment 14. Rarely the tubular vesicles on the same side are unequal.

There are certain interesting facts connected with the microscopic structure of these two kinds of sperm-sacs (Pl. XVII. figs. 10 *a*, 10 *b*). A firm membrane, the mesentery of septum 8/9, encloses the anterior testis, and the rosette belonging to somite 9 and the lower hinder surface of the sacs is bevelled and bright yellow in appearance, which marks the position of testis. The outer membrane can be easily removed by an incision, and the contents are a large lobulated yellow testis, in close contact with the rosette of the sperm-duct and seminal cells in various stages of development, together with large oval cells surrounded by a rich vascular plexus. In the neighbourhood of the testis are bundles of muscle-fibres, which surround the mass of seminal cells, which thus obliterate the cavity of the sac. The sperm mother-cells and sperm morula lie outside the vascular plexuses, and they, however, are richly granular and contain a large centrally situated nucleus. In transverse sections of the sac the seminal cells appear to be more centrally placed, being surrounded by muscular fibres and a very thick mass of ovoid cells. The testis is seen attached to the anterior face of the sac just in front of the funnel, the details of whose cellular structure are better made out in teased preparations. The funnel is certainly a large opening, only a part of which is, however, in contact with the testis, while the seminal cells almost fill the other part of the funnel. The large oval cells, which proliferate from the inner surface of the sac, obviously act as unicellular organs for the storage of reserve food-material.

Though in point of size and form the testis-vesicles of somite 10 differ from the anterior ones, yet in point of histological structure there is absolute identity. The outer wall of the sac in the case of the tubular vesicles is excessively thin and almost non-cellular, and accordingly the large oval cells enclosed in vascular plexuses show through, giving the organs a smooth velvety appearance. If xylol is used for the clearing purposes, this cellular investment easily comes off on applying needles for teasing, and the testis in each lobe is seen to form a tubular structure. This tubular testis stands out, because of the investment of circularly disposed muscular fibres. At the point where the two testis-tubes open into the common rosette they become continuous, and in the sac they are disposed in the form of three ridges of large hexagonal cells. The cavity, which is trigonal, is filled with masses of sperms. The main point in the structure of these curious sperm-vesicles is that the cavity is lined by a layer of large spermatocytes, which almost become continuous with the funnel-like expansion of the vas deferens. There is no seminal funnel in somite 10 beyond the sac-wall of the testis, over the base of which, as we have noticed, the vas deferens is continued as a sort of outer tunic, which obviously represents the funnel. The sperm-duct belonging to somite 9 is long and lies in a secondary mesenterial tube. Each duct turns inwards and pierces the very thin septum 9/10, and runs below the parietal lobes of the nephridium and joins the spermiducal gland on its upper anterior margin, just at the point where the second seminal duct enters it. The latter is a shorter and thicker non-convolute tube. In microscopical structure they resemble one another, except for the fact that in the shorter duct belonging to somite 10 there is an envelope of circular muscle-fibres outside the cubical epithelium, which is, however, ciliated in the longer duct belonging to the anterior somite. In the funnel of the anterior sperm-duct, the cells are more columnar and also ciliate. The cytoplasm stains deeply, and the nucleus is large and centrally placed in the funnel-cells. There is a distinct, though very thin, peritoneal outer layer for the posterior sperm-duct, which is simply an upward extension of the outer layer of the spermiducal gland.

The prostate or spermiducal gland (Pl. XVIII. fig. 10*j*) is a comparatively small structure, spherical and yellowish, and the greater part of the atrium is buried in the body-wall. It has two sources of blood-supply, both from the subintestinal and lateral longitudinal vessels, and small branches extend on to the sperm-vesicles. There are the usual two kinds of club-shaped glandular cells, the large and small ones, in addition to the more spherical, also glandular, cells. The circular muscles are confined to the duct-like prolongations of the gland-cells. There is a peritoneal investment, and groups of cells are found near the necks of the glandular larger cells, and the differences between these fourth group of cells and the glandular cells in their contents are more clear, stain less easily, and the spherical small nucleus is very clear in them. The cubical epithelium of the atrium is more or less horny on its inner surface. The outer lips of the male atrial orifice are swollen and comprise a mass of smaller oval glandular cells, which occur in great uniformity over the whole clitellum and the copulatory brackets themselves, which are several layers deep. In addition to these smaller cells, there occur in equal abundance the more common flask-shaped cells. Almost as a rule, whatever may be the shape and size of these gland-cells the nucleus is pushed to one side of the cell-body, and this position of the nucleus becomes so pronounced that it may be used for distinguishing the epithelial cells with granular cytoplasm, in which the cells are more centrally situated.

The occurrence of two pairs of sperm-vesicles in *D. somavarpatna* is not without significance in this genus, although in other earthworms it is almost a normal feature. In discussing the phyletic relations of the different genera of the family Moniligastridæ, Dr. Michaelsen, who, in the description of the species *D. willsi*, known from the Central Provinces, Deccan (Hyderabad), and W. Himalayas, records "Häufig rudimentare Prostaten im 9 Segment," remarks "that this structure confirms the statement of Rosa (adopted by myself) that the genus *Drawida* has arisen from the holoandric genus *Desmogaster* by the loss of the first pair of male organs, as well as a dislocation of all the generative organs, with the exception of the spermatheca." Dislocation of the generative organ there certainly has been in *D. somavarpatana*, in so far as the anterior sperm-duct has lost a separate exit (in the intersegmental groove 9/10), and a portion of it lies in segment 10, where it opens into the spermiducal gland, but the disappearance of one of the pairs of male organs has not taken place. There can be no doubt as to which pairs of seminal vesicles of *Desmogaster* those of *Drawida* correspond, and, in order to homologise them, it is necessary to assume that in its evolution *Drawida* has arisen by the suppression of somites 8 and 9 in the archaic ancestral *Desmogaster*. In one individual of *D. somavarpatana* in my collection I notice a partial suppression of segment 8, and in the Oligochæta generally similar partial or total disappearance of somites is not uncommon as individual variations. Furthermore, the suppression of somites must have preceded the disappearance of one pair of seminal vesicles in the course of descent, as is evidenced by the anatomy of sexual apparatus of both *D. willsi* and *D. somavarpatana*. If the hypothesis of the suppression of somites 8 and 9 is correct, then the anterior pair of the spermatheca of *Desmogaster* correspond with those of *Drawida*, the last hearts (segment 11) of *Desmogaster* would in that case lie in segment 9 in *Drawida*. The seminal vesicles suspended from septa 10/11 and 11/12 in *Desmogaster* would be homologous with those suspended by septum 9/10, and those lying in somites 11 in *D. somavarpatana*, and so with respect to the ovaries. It is obvious that the holoandric sexual apparatus of *D. somavarpatana* brings the genus *Drawida* nearer to *Desmogaster*, besides pointing to a possible immediate descent.

*Egg-sacs.*—They are large, trilobed (being constricted more or less by septa), yellow structures lying on the œsophagus and gizzards, and are suspended from the posterior face of septum 10/11. They extend as far behind as segment 16. The ovaries are greatly lobulated organs occupying the anterior end of sacs, and I have been completely unable to discover the oviducts. In the fully mature forms, the ventral portion of the septal mesentery forming the anterior end of the egg-sac has mostly atrophied, permitting the escape of ripe ova into the cœlomic chamber 11. I cannot state with certainty how the eggs escape outside. Each sac is full of granular matter, which escapes from it on the rupture of the wall and comprises masses of yolk-spherules. Under the microscope numerous ova in all stages of maturity can be detected in the mass of spherules, which obviously are reserve food of the egg as well as the developing embryo. I have not obtained the cocoons of this species, which must have a quantity of this reserve-food laid up for it.

If an egg-sac, removed from a fresh specimen dissected out of water, is passed through alcohols for fixing, it is seen that the wall of the sac gradually becomes transparent and the volume of yolk-material really occupies about $\frac{2}{3}$ of the sac, and the rest of the space is filled by a kind of albuminous matter, which is soon dissolved. That it is an albumin can be readily ascertained by the simple salt-solution test, and this second class of proteinaceous substance does not belong to the globulin series. I have not proceeded further in the chemical analysis of the contents of the egg-sac of this species of earthworm, and in microscopic structure (Pl. XVII. fig. 10) the wall of the vesicles comprises small glandular oval cells, which form the internal lining covered over by the septal mesentery. In the mass of the yolk-spherules is a rich network of blood-capillaries derived from the ventral and lateral longitudinal vessels. The albumin must be derived from the unicellular glands, which are modified cells of the cœlomic epithelium. It is an interesting fact in the physiology of the egg-sac that a part of it functions as vitellarium, and the female orifice must become considerably large for the extrusion of the eggs and the contents of the vesicles. The yolk is, however, the product of the vitellin or lecithin degeneration of the cytoplasm of the oogonia themselves. In the immature forms of this species the teased preparations of the egg sac show only ova as the principal contents of the vesicle, and the process of the formation of yolk in the sac can be followed in the slightly maturer worms. The nucleolus of some of the oocytes disappears in the nuclear sap, and perhaps escapes into the general mass of the cytoplasm, while that of others destined to become mature female cells remains unaffected. These modified cells increase in size, owing to a deposit of vitellin globules, and in the more advanced stages of degeneration the nucleus also is indistinguishable, and the modifying cytoplasm may be stained in certain areas of the cell-body, which represent yolk-nucleus. The cell-wall now degenerates also, and the mass of globules of yolk is held together only by an excessively thin pellicle, which breaks on the application of the slightest pressure.

*The Nervous System.*—Another feature of the anatomy of this species of earthworm that is really noteworthy is the extremely generalized structure of the nervous system (Pl. XVI. figs. 6, 6*a*). The nerve-cord is composed of two lateral bundles of fibres and cells, with clear fairly broad median hyaline space not occupied by any tissue elements. It is easily noticed by the naked eye that this median space is grey, and is thus distinguishable from the white bundles on either side. Among the fibres present in each division of the cord two kinds are distinguishable, viz., the axons of neurons and the giant fibres which are not traceable to any cells. The latter are laid in four bundles in the cord, two marginal and two internal sets. The internal bundles lie on both sides of the median dividing hyaline space. There are no ganglionic swellings in any part of the cord, which is of uniform thickness throughout. The nervous system of this species is almost ideally constructed for the study of the details of the structure of the cells and fibre-connections, and a slight teasing and suitable staining with methylin-blue will unravel the intricacies of the nerve-paths far too difficult to be made out by a similar process in the other species of earthworms. In paraffin sections the excessively thin cœlomic epithelium is found to form an investment of the dorsal half of the cord only, the histological elements are seen grouped on either side of the clear median space, and interstitial spaces are occupied by a granular substance. The granular mass must be in the nature of a matrix, which together with the giant fibres and the muscular fibres must help to bind the cells together. The hyaline membrane forms the outer layer which, in the processes of imbedding, usually breaks in all directions, appearing under magnification like a network of fibrils. In so far as the two lateral bundles remain apart the nerve-cord is a primitive structure, but as regards its cytological contents it does not appear to be so. Numerous kinds of cell-bodies are distinguished in the stained entire cord, and follow a strict law as regards their position throughout the cord and also in the œsophageal ganglia. Mention must be made of the strikingly large spherical cells which I term "Central Cells," apparently without any axons, which I have not succeeded in making out. There are four of them in each segmental division of the cord, two in front and two behind the nerves, and their position in the cord can be better understood by reference to the figure. They are regularly repeated throughout, and are situated on the central bundles of giant fibres on either side of the median clear space. In regard to the details of structure of these giant cells, I might mention that the large, centrally placed nucleus bears a deeply staining nucleolus. The nuclear membrane is thick and clearly defined, and the chromatin granules are strung out on the linin fibrils. The cytoplasm of these huge neurons is full of tigroid or Nissl bodies, comprising masses of neurochondrian granules in addition to less deeply-staining granules, mostly aggregated near the periphery of the cell. These latter, perhaps, represent the disintegrating particles of reserve food-material. The usual network of fibrils is also present, but apparently without any implantation cone or axons. In line with these larger cells are others which are indifferent in their structure and are fibrobalsts. They occur also in the marginal portions of the cord. The true neurons are of two kinds, those with one only and others with two nucleŏli. They differ from the giant cells in the possession of nerve-fibres, which lead out from them. Each axon immediately after emergence divides into two parts, the neurite and the dendrite. Even without teasing the nerve, it is easy to discover that there are eight of these neurons in each side of the ganglia or the point from which nerves are given off, and I have not noticed any neurite or dendrite crossing over from one side to the other. This is, again, a primitive organisation, and shows that each half of the cord is composed of self-contained ganglionic nerve-units. In regard to the structure of the nucleus and the cytoplasm, these axon-bearing neurons and others which occur always in pairs resemble the giant cells. Though there is no experimental or direct structural evidence to prove that the two kinds of axon-bearing cells are physiologically different, it is at least certain that the cells with double nucleoli cannot be functionally identical with those with a single nucleolus. In the prostomium it is possible to trace the neurites, both perceptory and distributory ones, from their source or origin to their insertion or ending, with breaks in the interval where the stain is unable to pick them. The fibres arising from the cells with double nucleolus are with difficulty traceable to the epithelial or sensory cells and tactile organs, and obviously the fibres springing from the other kind of cells with a single nucleolus must be motor in function. The margins of the cord and ganglia are composed of small oval cells with no fibres. The nucleus of these cells is small and stains deeply.

In the œsophageal ganglia the giant cells form almost an outer layer of cortex, while the oval cells aggregate round the bases of the nerves. The neurons are more deeply situated, but always in groups of four and four. The paired cells are absent from the two ganglia, and perhaps have been modified into neuroglia tissue or, better, neuroglia cells. Each of the neuroglia cells found associated with the groups of sensory and motor neurons is conical in outline, with nervous fine fibrils spread out among the other cells which they bind. Their bi- and trinuclear condition shows the syncytial tendency of these paired cells.

The communicatory dendrites of the sensory and motor neurons form an intricate plexus round the giant cells, which, perhaps in addition to the trophic function, may act also as a centre of cognition, and, though the absence of any processes from these large cells is not in favour of this view, yet their serial repetition in the cord, their position, and relation with the neurons on the œsophageal ganglia strongly point to their cerebral function.

The tactile bodies are the sensory epidermal swellings round the setæ, which just project beyond the surface of these whitish cutaneous swellings (Pl. XVII. fig. 7). In sections of skin taken in this region the swellings are noticed to occupy the distal half of the setal follicle, and are composed of two kinds of sensory elements. Those which are more filiform are apparently associated with the perception of movements, and hence are not sensory in the true sense of the term. They are closely related with the muscle-fibres which move the setæ and have also nerve-endings. The other kind of cells with which the filiform variety enters into intimate relation are shorter, spindle-shaped, with a granular deeply staining cytoplasm and central nucleus and nucleolus. These cells, at whose proximal ends the sensory fibrils enter, are more or less enclosed in a connective tissue vesicle, and hence constitute a true tactile organ. Between these cells enclosed in the vesicle is a small quantity of granular matter, which perhaps represents coagulated mucus and cellular debris, to which the whitishness of the papillæ must be due. Finer perceptory hairy processes, which are without any cytoplasm, project outside, forming a short hairy microscopic collar round the seta.

On the prostomium are found numerous aggregations of filiform cells in a state of uniform distribution, while at the tip and the sides of the tip are found curious pyramidal cell-associations, usually three in number (Pl. XVII. fig. 8). Their structure is identical with that of the spindle-shaped cells. The apex of the pyramid points outward and the sensory nerve-fibres enter the broad base. There is not any vesicular investment for them, and therefore they must be in the nature of primitive sensory organs, undoubtedly tactile in function.

*Locality.* Somavarpatana, Coorg, 4000 ft.

Type in the British Museum. Syntypes in Hamburg Zoological Museum, in the Indian Museum, Calcutta, and in the Central College, Bangalore.

### *Drawida scandens*, sp. n.

*External Characters.*—Length 30 mm. to 48 mm.; diameter at the thickest anterior part 2 mm. and at the narrowest posterior part 1·75 mm.; number of segments 115 to 145. Prostomium prolobous.

The setæ are closely paired, none on first somite. $aa = bc$; $dd = \frac{1}{2}$ circumference of body. The setæ on the anterior fifty somites are $1\frac{1}{2}$ to $1\frac{3}{4}$ times bigger than those on the hinder segments and are obliquely set. The longest setæ are ·6 and ·07 mm. at the nodule, and those from the hinder parts of the body measure ·32 and ·04 mm. at nodule. The free ends of longer setæ are spatulate and those of the shorter set pointed, an adaptation obviously connected with the scansorial habits of the worm. The base of the longer seta-groups is surrounded by a circular or slightly oval, discoidal, cutaneous, slightly raised marking.

Dorsal pores are present, fairly large, commencing from somites 16 or 17. Nephridial apertures large on seta-line *d*. The clitellum is well-marked, somites 9, 10, 11, 12, and 13 being affected; frequently somite 14 is also involved.

The genital markings are not elaborate and consist of an elevated circular area around the male orifices. The two areas may become confluent, producing a raised transverse pad. Similar markings may be found around the female pores. All these areas are bisected by intersegmental grooves. Atrial papillæ occur, and frequently show through the first pair of male apertures.

Spermathecal pores are simple, large in the intersegmental furrow 7/8 on seta-line *a*.

Two pairs of male apertures on seta-line *ab* in 9/10 and 10/11. Each aperture is a large transverse slit with tumid lips.

The female pores in 11/12 internal to seta-line *a*, conspicuous only in a few forms.

*Colour.*—Live specimens are bright deep green or almost blue, the clitellum being distinguished by crimson-red. The ventral median line is grey, almost transparent, through which the nerve-cord is visible. The red of the clitellum fades in the preserving fluids, and the warm blue degenerates into a dull olive-green.

*Internal Anatomy.*—The skin of this species of *Drawida* is structurally more complex than that of any other worm with which I am acquainted. When a few drops of formalin were added to the water in which the worms were plunged, they became coated all along the dorsal line with a dense milk white secretion in large drops. Being somewhat viscous, it dissolves in water with difficulty and hot water coagulates it. Obviously it is rich in albuminous contents and has a slight alkaline reaction; when dried it forms minute cubic crystals. This phenomenon, not noticeable in any of the other species in my collection, led to a microscopic examination of the sections of skin (Pl. XVII. fig. 9). It comprises the usual layers of polyhedral epidermal cells; the chromatophores form a fairly thick layer below. I do not find any difference as regards the structure between the chromocytes bearing the green pigment on the body and those bearing the red on the clitellum. In addition to the ampulliform mucous cells situated between the polyhedral epidermal cells, there occurs another type of glands composed of syncytial aggregation of a large number of cells. There are a pair of such glands in each somite, placed at right angles to the axis of the body on the dorsal surface. The border of the gland is sinuous, indicating the incomplete fusion of the cells, whose boundaries are not, however, recognisable in the body of the structure. The spaces seen in the body of the gland constitute the duct, which is intracellular, and the external orifice is placed close to the dorsal pore on either side. Microscopically examined, the secretion shows the presence of cœlomic corpuscles, which must have been added to it outside the body. Many species of *Megascolex*, *Acanthodrilus*, and *Octochætes* are known to extrude quantities of cœlomic fluid under irritation besides the ordinary mucus, but a specific secretion of this nature is remarkable in a worm not distinguished much by size.

*Muscular System.*—Around the seta-follicles in the anterior somites the skin is disposed in discoidal form with a distinct annular rim. The disc is composed of circularly arranged muscle-fibres, while, at any rate, some of them belong to the transverse series, for a few of these sphincter-like fibres are continuous with the bundles composing the transverse bands on the genital somites. There can be little doubt that they must be associated with the habits of climbing vertical surfaces. The additional internal transverse bands of muscles in the genital somites are absent.

Septa 6/7, 8/9 are very thick, chiefly the last two; septum 9/10 only slightly so, while the succeeding ones are very tender. Septa 8/9 and 9/10 may be dislocated backward and forward respectively by a somite's length (Pl. XV. fig. 3 *b*).

*Alimentary Canal.*—Pharynx is large and muscular, occupying more than three segments, and the muscle-bands have the usual thickened appearance of septa. Œsophagus simple, slender, extending up to somite 10. Gizzards three, fairly large, occupying somites 10–16 or 11–16. No dorsal enteric appendages, or only a few are present. There is no typhlosole.

*Circulatory System.*—There are five hearts, the last being placed in segment 10. A lateral longitudinal vessel is present, extending up to somite 22, connected to the dorsal vessel by secondary commisures which are given off from the hearts near their point of origin. The vessels are mainly composed of connective tissue, the muscle-fibres being confined practically to the hearts.

*Genital System.*—The male organs comprise *two* pairs of testis-sacs, suspended by septum 9/10 on its anterior and posterior faces, those of one side right or left in a state of fusion. The septum 8/9 is usually very thick and generally, though not as a rule, dislocated backwards, and the seminal vesicle belonging to this septum leaves its place of origin and becomes attached to the anterior wall of septum 9/10. All the vesicles lie close together dorsally over the œsophagus, or may lie separated below this structure. The combined, yet distinctly bilobed, seminal vesicles are restricted to their own somites, if the septum 8/9 is not backwardly deflected; the testis-somites are nearly $1\frac{1}{2}$ times larger than those in front or behind. In sectional preparations (Pl. XVIII. fig. 10 *c*) the spermatocytes are seen to occupy respectively the anterior inner border of their vesicles, the seminal funnel being in intimate contact with the testes. The other contents of the vesicles are sperms and trophocytes in various stages of development. The mesenterial wall forms a dense membrane, and is further supported by the presence of muscle-fibres, mostly irregalarly disposed. The sperm-ducts are led off from the inner margins of the vesicles and are short, spirally coiled tubes, hidden by the lobate sacs themselves and the nephridia. Each duct enters the spermiducal gland near its anterior base. The prostate gland of each duct is long, whitish, soft in texture, pear-shaped or nearly cylindrical, readily comes to view on opening the worm, and is attached to the body-wall at the posterior face of septa 9/10 and 10/11. In microscopic preparations, the gland is seen to be composed of short club-shaped glands and circular muscle-fibres with the cubical epithelial lining. The atrial papillæ, developed more prominently in connection with the anterior male apertures, consist of an outer cuboid cell-layer and two sets of muscle-fibres derived from the body-wall. They are free from glandular bodies.

There can be little doubt that this species of *Drawida* is the most archaic of the known species, in possessing a more complete holoandric sexual apparatus than even *D. somavarpatana*, and indeed these two species render the generic character of the reproductive organ of the group, at least in one of their aspects, less universally applicable.

The ovaries are whitish-looking delicate bodies hanging from the anterior face of septum 10/11 without being contained in any specialized ovarian chamber. A greater part of the ovary lies in the sac, which is slender, constricted by septa 11/12 and 12/13, occupying nearly three somites, and lying over the first two gizzards. An entire sac examined under the low power of the microscope, even without much clearing, shows oocytes in different stages of maturation. I have not been able to make out an oviduct in any of the six examples investigated, and the chamber of somite 11 perhaps acts as a provisional chamber for the reception and extrusion of ova.

The spermathecal apparatus of this species approaches the condition met with in *Megascolex*. There is not any well-marked ampulla, possessing a structure comparable with that of the other species described in this paper. The duct has a slight dilatation which lies on the posterior face of septum 7/8 between the heart and the secondary vascular commissure, and is thus ventral in position to the dorsal vessel and the œsophagus. The duct is thin and spirally coiled ; it penetrates septum 7/8 and enters the base of the atrial vesicle on its inner margin. The duct and its dilatation do not differ structurally, and hence an ampulla in the true sense of the term does not occur in this species, which, so far as I know, is the solitary example of the genus in this respect. The atrial or copulatory pouches are large, flattened antero-posteriorly, slightly bifid at the top. They occupy the greater portion of somite 7, in close relation with the lateral longitudinal vessel. The cavity of the pouch is narrow and irregular, and is lined by a columnar layer of glandular cells with large nuclei at the base. The cavity extends right up to the bifid ends of the pouch. The layer of circular muscles and the external layer of cells form a dense investment, which accounts for the compact texture of the organ. In sectional preparations the cavity was found full of granular material, some staining deeper than others, composing sperma and a mucous base.

Here is further evidence in support of my view that the atrial pouch, wherever one is present in *Drawida*, acts as a magazine of sperma, besides discharging a secondary secretory function.

The Nephridial System, which is meganephric, is not distinguished by any of the characters described in connection with *D. somavarpatana*.

The *Nervous System* and *Sensory Organs* do not call for any comments. The latter are filiform cells associated with the perception of movement, occurring largely on the prostomium and anterior somites.

*Remarks.*—I am unable to state precisely the nature of the function of the thick cutaneous humour, which is probably protective. At the time of collecting, which was after a slight drizzle in the morning, the worms were found either crawling about or climbing dense herbage, from which most of my specimens were taken.

*Locality.* Bhagamandala, 4000 ft., Coorg, S. India.

Type in the British Museum. Syntypes in the Indian Museum, Calcutta, and the Central College, Bangalore, and Hamburg Zoological Museum.

### *Drawida elegans*, sp. n.

*External Characters.*— Length of preserved specimens 135 mm.; fully stretched live specimen 155 mm.; maximum diameter in the preclitellar region 7 mm. and behind 5 mm. Number of segments 200. The preclitellar somites, which are strongly telescoped, are three times as long as the postclitellar ones. All the segments bear annular ridges, on which the setæ are placed. These ridges are inconspicuous on the hinder somites, which become extremely short in front of anus.

Prostomium long and prolobous.

Setæ are small and closely paired in the anterior two-thirds of the body, while those behind are slightly larger occasionally. First somite free. $aa = bc$ or broader in the preclitellar region ; in the postclitellar region $aa = 2/3\ bc$.

Dorsal pores present, commencing behind the clitellum.

Clitellum is definitely marked, extending over segments 10–13.

The genital markings are either completely absent or may comprise short segmental grooves and thickenings in front and behind the genital orifices, which may be connected by these grooves, as in some examples in the collection. In a few immature forms a faint dome-shaped swelling is present between and in front of the female apertures, which in some cases may be connected with the male pores by comparatively shallow grooves. Occasionally an oval thickening marked whitish surrounds the spermathecal opening. In some specimens which are fairly mature, there are slightly raised, thick, white patches on somites 5, 6, 7, 8, 9, and 10 without any genital significance, confined either to the ventral or dorsal surface of the body-wall ; such white patches on the contiguous segments become confluent, and do not in any case occupy more than 1/3 of the body-diameter.

Spermathecal apertures in groove 7/8 in seta-line *cd*.

Male openings in intersegmental groove 7/8 are transverse slits, surrounded by two swollen lips and are halfway between *bc*. Atrial papillæ occasionally project through the apertures.

Female orifices inconspicuous in furrow 11/12 on seta-line *a*.

Nephridial openings large in seta-line *d*.

The colour of this species of earthworm is very widely variable. Most specimens in the living condition were bright pink with milk-white or olive-green on the posterior one-third of the body. Occasionally the pink was replaced by a pale violet or saffron-yellow with the same colour-markings as in the first case. In the preserved specimens the pink and white entirely fade, but traces of the other colours are retained.

*Internal Anatomy.*—In the larger worms the skin, specially in the preclitellar and hinder regions of the body, is very thick and is almost leathery, due to the development of the muscles and a peculiar form of connective-tissue fibres. In the macerated stained preparations of the skin, some of these fibres which lie above the circular muscles possess a beaded structure, showing their multicellular origin. Others are wavy and are disposed longitudinally—a fibre extending over more than two somites. The wavy fibres are not granular, while the cells included in the beaded variety, which is an incipient fibre, are deeply stained (hæmatoxylin). It is to these fibres that the toughness of the skin-texture and its considerable elasticity are due. In sections of the skin obtained from the posterior white portion, the occurrence of large cubical cells with considerably thick walls, either empty or full of a deeply staining mass, forms a conspicuous feature. The granular mass is the coagulated mucus whose presence accounts for the milk-whiteness of this region of the body. In the specimens in which the preserving fluids have thoroughly dissolved the lipochrome pigments and the mucus of the cells, the skin, chiefly in the anterior region, becomes transparent, through which the reproductive organs, the nerve-cord, and the subneural vessel can be seen. But the opacity of the skin in the posterior part is due to the inaccessibility of the mucous cells to the solvent action of spirit, for the superficial epidermal cells in this region form a fairly thick corium.

Septa 5/6–8/9 are very muscular, about three times as thick as the skin, are shifted backwards about the distance of three somites, and are telescoped into each other. In consequence of the backward deflection of septum 8/9 extending as far behind as somite 11, septa 9/10, 10/11 are absent or are only imperfectly developed. In the region of the gizzards, a fusion of septa 13/14 and 20/21 may take place in some mature forms, and only imperfectly so in others. The succeeding septa are tender up to somite 120, when they again become as thick as or thicker than the skin. Septa 11/12 and 12/13 form an imperfect ovarian chamber.

There are generally four, occasionally five, hard-walled yellow gizzards, occupying somites 13–21. Each gizzard is very large and muscular, taking up two segments, and the softer annuli between them are very greatly developed. These are followed by a series of 3 to 6 softer gizzards, smaller than the anterior ones, placed in segments 22 to 30; thus each of these secondary ones also taking up a segment. The alimentary canal is thin and is without a typhlosole, and behind segment 120 the intestine becomes conspicuously white and thick-walled. In transverse sections the lumen of the intestine appears as a narrow vertical slit, the walls touching one another. The intestinal wall in this region is composed of very greatly developed circular muscles, with radiating bundles of the same tissue, which in the intersegmental constrictions pass into the septa. Scattered throughout the wall are oval cells, which form a definite layer on the outer surface; each cell contains a deeply staining protoplasmic mass and a central nucleus. Such cells occur over the entire intestinal wall behind the gizzards. The cavity of the intestine is lined by a double layer of chloragogen and columnar cells. The latter are irregular in outline, producing a jagged appearance on the inner surface. Judged from the nature of the occurrence and distribution of the oval cells, a great many of them are found in the muscles of the body-wall, it is possible to infer that they are associated with the absorption and transmission of food.

Alimentary appendages are present; those on the softer gizzards are extremely vascular. The vessels of these appendages are derived either from the dorsal vessel or from the supraintestinal trunk.

The last heart is in somite 10. The dorsal vessel over the gizzards and anteriorly is considerably stout, and follows a more or less zigzag course. The most anterior heart is in segment 6. In the majority of forms in my collection there is a supra-intestinal vessel. The phenomenon of opacity is common to the dorsal vessel and the last hearts. Secondary commissures are only rarely present, as the occurrence of the lateral longitudinal vessels is arbitrary. A supra- and an infraneural vessel is present, the latter together with the nerve-cord is visible through the transparent skin. The distribution of the vessels is similar to the plan described in *D. somavarpatana*.

The testis-sacs depend from the remains of septum 9/10, and occupy segments 10 and 11. Each sac is an irregular oval body, more or less attached to the dorsal vessel and the hearts by the mesenterial wall. Its histological structure and arrangement of testis-cells and funnel are identical with those of the anterior pair of vesicles described in *D. somavarpatana*. In the testis-sac the position of the funnel is easily made out from the area of iridescent shimmer on its wall.

The sperm-duct leads off from the posterior ventral margin of the sac, and forms a dense matted structure adhering to the wall of the vesicle, which it partly covers. The duct, which when in the matted condition occupies nearly three somites, is fairly thick, due to the large development of the circular muscles around the internal ciliated epithelium, and when uncoiled is over 65 to 70 mm. long. The duct enters the prostate at its apex, which is slightly indented.

The spermiducal gland, or the prostate, is a large pyriform organ sessile on the body-wall, its vertical axis being twice or slightly more than twice its antero-posterior diameter. In some specimens the glandular part with its club-shaped cells is really confined to the ental and ectal divisions, while the rest of the wall is composed of a few muscle-fibres and cubical epithelial cells, thus converting the glandular structure into a vesicle in which the sperm-duct lies in several coils. The atrial papillæ are comparatively small.

There is an ovarian chamber, *i. e.* segment 11 remains closed on opening the worm, though sometimes the sides may rupture on stretching the animal. The ovisac, which looks rather like the pistil of the pea, protudes from this chamber into segments 12 to 14. The ovary is enclosed in the sacs, which lie over or on the sides of the first two gizzards. There is no oviduct, but the side-walls of the ovarian chamber approximate so as to form separate ovarian conduits. The female aperture is small in all the forms investigated.

The spermathecal ampullæ (Pl. XV. fig. 3 *c*) are lodged in depressions on the posterior face of the fat septum 7/8, and are completely hidden by the equally thickened posterior septum. Sometimes the depressions for the lodgement are absent. The two ampullæ are close together, being separated only by the dorsal vessel. In shape they are subspherical and are whitish-looking. In the teased preparations the contents were only a coagulated albuminous mass easily dissolved by alcohol and acetic acid. The microscopic structure of the ampulla is identical with that of the similar structure of *D. somavarpatna.* The spermathecal duct is fairly thick and lies in a few coils in the large cavity of somite 8, and penetrates the septum 7/8 at the base, and follows the somewhat tortuous course in the hinder part of somite 7. It enters the atrial pouch at its apex, which it fairly deeply pitted. The vesicle is a large, strongly muscular, pear-shaped gland fixed to the body-wall by the narrow end. It lies fore and aft to the long axis of the body. The sides of septum 6/7 are greatly hollowed out for the reception of these glands, in which the duct opens out into a large sac. In the fully mature forms the atrial pouch looks like a barrel with spiral hoops of muscle-bands, which form a conspicuous external feature. The glandular portion in such a case is confined to the two ends of the organ. The cavity of the vesicle is composed of a lining membrane (Pl. XVIII. fig. 10 *d*), whose cells are much larger than than those of the duct, and by their greatly irregular arrangement give rise to recesses in the chamber. Surrounding this internal membrane is a mass of subspherical cells, which on account of mutal pressure may assume an oval shape. These and the lining cells stain deeply, and the nucleus in them is large and centrally placed. A few of these surrounding spherical cells look empty in sections, having previously discharged their contents into the vesicular chamber. None of these glandular cells possess any ductules. In the more mature forms, in which the muscles of the pouch are gathered into spiral hoops, the internal cavity is disposed into a slight spiral form, and in those forms in which the muscles are not so aggregated they form a close and continuous investment, which accounts for the very tough character of the whole organ. The outer membrane of the pouch is composed of numerous layers of cubical cells, those at the surface being almost flat. The protoplasm of these cells is granular, and the nucleus stains deeply. The blood-vessels run in all directions in the substance of the gland, and in the transverse section they appear cut across and also lengthwise. The whole wall is further impregnated by a mass of white granular substance of an albuminous nature, staining with hæmatoxylin and derived from the glandular cells. It is the presence of these bodies which gives a milky-white shimmer and opacity to these organs, which become almost transparent on dissolving them.

The nephridial system of this species of *Drawida* is remarkable. The nephridia in the hinder region of the body, where the alimentary canal becomes thicker, give off a duct from the third lobe, which opens into the intestine. The tubules from the two nephridia in any segment in this region have a separate opening. Thus each nephridium opens outside on the seta-line *cd*, as well as into the intestine. More anteriorly, the nephridia seem to have a similar secondary opening into the intestine, at least into the gizzards, but I have not succeeded in finding out if all the nephridia have an intestinal opening. Depending from the third lobe, close to the point where a vascular twig from the subintestinal vessel enters it, is an accessory lobe, more or less sacculated, containing minute bluish spherical bodies, which lie on either side of the non-ciliated wide duct. Possibly these bodies are concretions of waste matter. These accessory lobes are absent from the more anteriorly placed nephridia. In addition to the meganephridia, each somite contains a pair of integumentary nephridia also. These are composed of a much convoluted glandular tubule attached to the peritoneal wall, being separated from its fellow on the opposite side by the dorsal and ventral mesenteries. They occur throughout in all somites, except the first three anterior ones. The lobes of the integumentary nephridia are whitish-looking mushroom-like structures composed of twisted tubules, and are placed on the seta-line *cd*, where they open along with the meganephridia. The lobes of the integumentary nephridia are a characteristic feature of the internal surface of the body-wall in the opened specimens. I am not quite sure whether there are two independent nephridiopores, and I have not succeeded in making out how the integumentary tubule opens outside. The integumentary nephridium has not a funnel-like nephrostone, which, however, is represented by a simple dilatation of the inferior limb in the mid-ventral line. The ductules of the integumentary nephridia are absolutely narrower than those of the meganephridia.

The nervous system and sensory organs do not call for any further remark than that the latter are in every respect like those of *D. somavarpatana*. The nervous system is more highly organised than in the case of the two foregoing species described here.

*Locality*. Bhagamandala, 4000 ft., Coorg, S. India. The type is in the British Museum; syntypes with Prof. Dr. W. M. Michaelsen, in the Indian Museum, Calcutta, and in the Central College, Bangalore.

### *Drawida modesta*, sp. n.

*External Characters*.—Length 72 mm., diameter in the preclitellar region 6 mm. and in the postclitellar part $4\frac{1}{2}$ mm.; number of segments 221, those of the middle and the hinder part of the body are very short.

The setæ are moderately large, closely paired, $aa = bc$. The first somite is free from setæ. *dd* is less than half the circumference.

Prostomium very small and prolobous.

No dorsal pores.

Clitellum well-marked over segments 10–13. The genital markings are simple. The ventral part of somite 7, between the spermathecal openings, is hollow, terminating on either side anteriorly in a conspicuous oval grey glandular lobe of skin, a feature which I have not noticed in any other species of *Drawida* with which I am acquainted. Around and between the male orifices is a fairly deep oval groove. A similar marking of grooves is present around the female pores also. On somites 9 and 8 there are faint circular markings in the line of genital pores. The male apertures with thick lips are large transverse slits in the furrow 10/11, extending nearly over half *aa* and outwardly nearly over half *bc*. The slit is straight, and the depression surrounding it is confined to the posterior half of somite 10. The female orifice is as large as the male opening, situated externally to seta-line *b*.

Each of the female pores extends inwards as far towards the median line as the male orifices do. The lips are swollen. The body-wall in the mid-ventral line between the depressions surrounding the genital pores is raised in the form of a ridge. The spermathecal pores are large, slit-like, curved openings in line with the male pores, the chief convexity being directed posteriorly. In front of each slit is the already noticed glandular oval thickenings of the skin. The nephridial pores are placed on seta-line *cd*.

The colour of live specimens was distinguished by a grey clitellum, the preclitellar portion was a mixture of yellow and brown. The rest of the body was deep yellow with blotches of brown. In the preserved specimen the yellow is present only poorly.

*Internal Anatomy.*—The skin is very tough and leathery, and in point of histological structure is like the skin of the foregoing species, *D. elegans*.

Additional internal circular muscles in the genital somites are present.

Septa 5/6–8/9 are very thick; the posterior face of septa 7/8 and 8/9 bear deep annular grooves with corresponding ridges on the opposite surface. Septa 9/10 and 10/11 are extremely tender or have atrophied. Subsequent ones are excessively thin.

There are two gizzards occupying somites 10–14. The anterior is soft-walled, occupies 1½ segments, and the posterior is large, thick-walled, taking up 3½ segments. The alimentary appendages are few and fairly large.

In regard to structure and disposition of vessels, the circulatory system of this species is similar to those of *D. somavarpatana*.

The testicular sacs are very large, and, instead of depending from the posterior face of septum 9/10, are attached to the body-wall. This is the first example of *Drawida* in which a sessile seminal vesicle is reported. Each vesicle has convex outer surface, the anterior and posterior faces are either bevelled or are hollow, and the inner margin, which is a narrow ridge, is transversely ribbed. In cross-section it is like the sector of a circle with the radii bent in. The length of vesicles is greater than their breadth by about a fourth, and they occupy more than $2\frac{1}{2}$ segments (9, 10) and nearly the whole of 11. The sacs, which are visible through the translucent skin, are attached to the body-wall on the ventro-lateral line, external to the prostates, and round the base of attachment there is a furred white membrane which represents the remnants of septum 9/10. Septum 8/9 is also deflected backwards over the testicular vesicles, forming an additional external investment. The testis is a large mushroom-like organ placed about the middle of the vesicle. The funnel is closely attached to it, and the position of the former is externally marked on the inner ridged portion of the vesicle by a rectangular iridescent area, from which the sperm-duct leads off. In the first part of its course the duct is spirally twisted, and runs inwards. It doubles backwards, and is entangled in the mass of tubules belonging to the nephridial lobes, blood-vessels, and muscle-fibres. The duct enters the prostate on its posterior face. The spermiducal gland is a white, cushion-like, spherical body, sessile on the body-wall in segment 10 close to the base of septum 10/11. In point of microscopic structure, the gland is in every detail like that of *D. somavarpatana*. The atrium is without a papilla.

The ovisacs are of considerable size, extending backwards up to somite 14 and overlapping the gizzards in the mid-dorsal line. On opening the worm, the contents, a mass of yellow yolk, tumbled out; the wall of the sac, being excessively thin, ruptures on the addition of the slightest pressure. When examined microspically the yellow spherules were found to form a dense covering for the very large ovum. I have not been able to make out what the ovary is like. The oviduct is large and convoluted, and its mouth commences at the point of the non-fusion of septa 10/11 and 11/12, which, however, adhere everywhere, forming a kind of spacious chamber. The stem and the greater part of the sac, together with the oviduct, are included in this chamber. The duct opens at the base of the posterior face of septum 11/12.

The ampulla of the spermathecal apparatus is situated over the nephridial arch on the posterior face of septum 7/8, to which, however, it is not attached. It is subtriangular in shape, the apex being directed inwards, the anterior and posterior faces converging towards the ventral ridge. Thus in vertical section also the ampullæ are triangular. They are conspicuously white and nestle in the septal grooves, and overlap the hearts and the dorsal vessel. From the middle of the ventral ridge is given off the large duct, whose coils are hidden by the ampullæ, the nephridia, and the hearts, which are exceedingly thick-walled and large. The duct enters the atrial pouch at its summit ; the pouch itself is imbedded in the septal wall 7/8 (Pl. XV. fig. 2 D). Consequently the duct does not penetrate it. The pouch is cylindrical and thin-walled, into which the duct opens out into a large chamber. The microscopic structure of the pouch is in every detail like that which is met with in the ectal end of the atrial pouch of *D. somavarpatana* already described. In the preparations of the pouch and the ampulla I did not find any sperma.

*Nephridial System* meganephric. The nephrostome has a secondary funnel. None open into the intestine, except the anterior ones in the pharyngeal region.

The nervous system is highly organized, like that of *D. elegans*.

*Locality*. Moornad (Hill valleys, 3500 ft.), Coorg, S. India.

The type is in the British Museum ; syntype in the Central College, Bangalore. Only two specimens are included in the Collection.

### *Drawida paradoxa*, sp. n.

*External Characters*.—Length 90 mm. ; preclitellar diameter 5 mm. ; postclitellar diameter 4 mm. ; number of segments, 152. Preclitellar somites telescoped and twice as large as the postclitellar ones. No secondary annulations.

Prostomium very large and prolobous.

Setæ are small, closely paired : $aa = bc$ generally throughout, though in some specimens $aa$ is less than $bc$ in the anterior somites ; $dd = \frac{1}{2}$ circumference of body. The seta-lines are distinctly marked by broad longitudinal grooves, produced apparently by the muscle-bundles slightly diverging from one another. The setal bases are surrounded by conspicuous, white, papilla-like elevations, having the same microscopic structure as those described under *D. somavarpatana*.

The limits of the clitellum are indefinite, but yet can be marked by the slight thickening of the body-wall of somites 10–13.

Dorsal pores are present, and commence from behind the clitellum from somite 14 or possibly 15.

No genital markings.

Spermathecal and female apertures not visible. The male orifice is equally indistinct in the majority of forms examined, and only in a few appear as curved slits in the furrow 10/11 external to seta-line *b*.

Nephridial pores on seta-line *d*.

The colour of these forms at the time of capture was a deep chocolate anteriorly and greenish brown over the posterior half of the body. In the spirit-specimens the chocolate is rendered into a pale violet or mauve, and the rest of the body is pale brownish.

*Internal Anatomy.*—The first recognisable septum is 2/3, and is broken up laterally. Septa 3/4 and 4/5 have the same ill-defined lateral walls, their place being taken by powerful muscles, which form part of the pharyngeal muscular system. Septa 5/6–8/9 are thick. The succeeding ones are tender.

The pharynx is muscular and occupies four somites (2–5). The retractor muscles, which connect the pharynx to the parietes, bear masses of glandular cells in somites 3–5 nearer to their pharyngeal ends. In the species of *Drawida* described and others to which reference is made in this paper as having been subjected to investigation, I have noticed the presence of white glandular masses of cells on the posterior face of septa 2/3–4/5. Examined microscopically, the masses are seen to be composed of spherical cells mainly aggregated round the septal vessels, and may be therefore looked upon in the nature of blood-glands, though in a very incipient condition of development. I have not been able to detect any ductule issuing from these septal blood-glands, nor from the gland-masses aggregated on the muscle-bands of this species. In segment 5, however, of *D. paradoxa* are found masses of distinct glandular lobes, white, more or less flattened, and closely applied to the dorsal and lateral pharyngeal wall, completely hidden by the forward deflection of the septum 5/6. When an entire gland is removed with its connections, cleared, and examined, a ramifying system of canalicules, which obviously drain the cellular secretion, may be detected. The cells themselves are large spherical bodies full of granular cytoplasm, with a distinct, centrally situated, large, rounded nucleus. A few muscle-fibres constitute the matrix of these glands, which have no relation with the septum. In the sectional preparations the discrete openings of these glands into the pharynx and a glandular pharyngeal epithelium, having essentially a cytological structure similar to the glands, are detectable. There can be little doubt as regards the glandular pharyngeal epithelium discharging a digestive function, and in that case the glands in somites 5 and those on the pharyngeal muscle-band may be simply water-conserving organs. Unfortunately, there was not an opportunity to do any experimental work on the physiology of these organs.

There are three bigger gizzards occupying somites 12–14, the first one softer and more conically built, and the hinder two firm and spherical. The fourth gizzard in somite 15 is just half the size of the spherical one in front, and is hidden from view. The wall of the intestine in somites 16–17 is very muscular, and simulates the appearance of gizzards. Enteric appendages are conspicuously developed, as in *D. somavarpatana* and *D. elegans*, and the number of digitate lobes present in any appendage may reach about 20, some of which at any rate are in an incipient stage of development. The one feature about these appendages which requires mention is the fact that these lobes become in some forms enveloped in a distinct peritoneal membrane, which passes over the dorsal vessel, thus becoming organised into a lobate gland.

The dorsal vessel in somites 5–17 is greatly thickened, and follows a greatly tortuous course in somites 12–17. The last heart is in segment 9; occasionally an additional one in segment 10. There is a subneural vessel.

The testicular sacs lying in segments 9–10 are large, spherical, opaque bodies, rather greyish, covered over dorsally by the backward deflection of septum 9/10 (Pl. XV. fig. 3 *c*). They meet over the dorsal vessel in the median line. From the inner lower border of each vesicle is given off the spermiduct, which is large, lying in two most intricately coiled masses, each nearly as large as the testicular sac itself. These spermiducal masses lie on the sides of, in close contact with, the sacs and below the œsophagus. From the subœsophageal mass the coiled vas deferens issues to meet the prostate, which is engrafted on a second testicular sac. The testis of the spherical vessels is attached to their lower inner border, closely adherent to the funnel, whose position is easily detected by the iridescent or golden-yellow area from which the muscles of the sacs radiate. The engrafted prostate surrounds the second tubular vesicles on the top and the anterior and posterior margins, the sides being free, and extending ventrally only up to the point where the thicker second vas deferens commences. The spermiduct belonging to the spherical vesicle enters the engrafted prostate at about half its height anteriorly. The cylindrical vesicle pushes backward the septum 10/11 by about the length of nearly two somites, and is encapsuled by it and two other posterior septa. Owing to the prostates the entire structure is flat. From below, a stout bent tube, the second vas deferens, is given off and is inserted into the upper end of the posterior division of the sessile prostates. In the sectional preparations the histological elements composing the sessile prostates are also met with in those of the spermiducal gland surrounding the tubular vesicle, in which the arrangement of the second testis is same as what has been described in the similar organs of *D. somavarpatana*. The coiled vas deferens of the spherical vesicles enters the tubular vesicle, and below this point the cells of the lining membrane of the latter lose all the character of spermatocytes and rather resemble those of spermiduct itself. Near the ental end of the second tubular sacs the sperm parent-cells are found in various stages of division.

The arrangement of the male reproductive apparatus of this species is very like that of *D. somavarpatana*, but only with such differences as have been indicated above. Strong broad bands of muscles connect the second pair of vesicles to the body-wall on both sides, such as have not been observed in any other species. This mode of attaching accounts for the difficulty of erecting the sacs for the purpose of examination.

The egg-sacs, which lie over the first gizzard, are shifted backwards by the length of two somites. They are slender tubular structures, mainly composed of yolk-platelets ; the ovaries, which are tufted organs, are attached to the stem of the sacs. Septa 10/11 and 11/12 are juxtaposed, but do not fuse, and the cœlomic chamber of segment 11 is nearly a shut cavity in which a coiled glandular oviduct lies, whose funnel is indistinguishably situated in the ovarian mass.

The ampulla of the spermathecal apparatus is small, oval, being situated on either side of the dorsal vessel in somite 8, only loosely attached to the posterior face of septum 7/8. The duct is thin and is only moderately coiled. It runs outwards, penetrates the septum 7/8 considerably over the ventral body-wall; the greater part of its further course lies in the thickness of this septum, which it leaves at the base for insertion dorsally into the anterior lobe of the copulatory pouch. The pouch is double-lobed, with a median constriction dividing the organ into unequal anterior and posterior parts (Pl. XV. fig. 2 E). The whole pouch lies in segment 7, and pushes backwards considerably over half a somite the septum 7/8. The cavity of the pouches is divided into a number of incomplete horizontal compartments with ridges, which, though running round the inner wall of the lobes, are discontinuous. In sectional preparations the ridges appear to be composed of a cord of small spherical cells with longitudinally disposed muscle-fibres, the whole of the ridge being compactly held by a thin cuticular pellicle. The entire pouch perhaps represents the greatly modified atrial tubules of *Moniligaster perrieri*—a view which in some measure receives support from the fact that these ridges are canalised in the case of forms which are just developing the spermathecal apparatus, and the peritoneal wall encapsuling them is still thin and devoid of muscle-fibres (Pl. XVIII. figs. 10 *h* & 10 *i*). The more complete organisation of the peritoneal investment into the atrial pouch must synchronise with the degeneration of the tubes into incomplete ridges.

*The Nephridial System.*—The vesicle in this species is non-glandular, unlike the other examples described in this paper, and hence has the same structure as that described in *D. grandis* (Pl. XVI. fig. 5). It is quite transparent, being composed of a few circularly disposed muscle-fibres, and, in the case of anterior somites in the front of the clitellum and even in some examples behind it, the vesicle opens by a broad circular aperture into the respective cœlomic chamber. A glandular vesicle is not, however, uncommon even in this species and then they are white and perfectly opaque. The nephridial lobes and their relation to the other structures are so different in this and the other species described in this paper from the figure of *D. grandis* given by Bourne (pl. xxvii. fig. 42, Q. J. M. Sci. vol. xxxvi.), that a few words respecting the renal organs will not be inappropriate here. The two vesicles form nearly a complete ring round the alimentary canal, almost meeting dorsally, but extending only halfway ventrally below the intestine. From the lower half of its stem is given off the slightly coiled muscular duct, which runs outwards to open on the seta-line *cd*. Among the glandular lobes we recognize the twisted and the looped ones. There are two of the former kind, one being longer than the other, both ventral to the alimentary canal, and the longer twisted lobes on each side are only separated by the nerve-cord. There are three looped lobes: two of them are in close relation to the sides of the alimentary canal on the inner side of the vesicle, and the third more or less attached to the muscular tube, and hence on the outer side of the vesicle. The funnel-tube enters the main glandular mass at the point where the inner looped and the twisted lobes diverge, and the duct of the funnel-tube also divides, entering respectively the two main divisions of the nephridial structure. In regard to the histological structure of the different parts, excepting the nephrostome, which is same as in *D. somavarpatana*, the nephridia of this species do not differ, from those of *D. grandis*, of which we have a most elaborate account by Bourne.

*The Nervous System.*—Both the cord and the œsophageal nerve-mass show the same disposition of the histological elements discussed under *D. somavarpatana,* and perhaps the only feature which distinguishes *D. paradoxa* is the absence of the large spherical central cells occurring in the internodes of the nerve-cord and also in œsophageal nerve-mass. This primitive character of the nervous system, associated with the presence of two pairs of testicular vesicles in two species of *Drawida*, is a morphological fact worth calling attention to.

*Locality.* Madapur (Coorg, S. India), Hill forests, 3500 ft. Type in the British Museum, syntypes, with Prof. Dr. Michaelsen, Hamburg, in the Indian Museum, Calcutta, and the Central College, Bangalore.

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## EXPLANATION OF THE PLATES.

### Plate XV.

*Fig.* 1 A, B, C, D, and E represent the genital markings and orifices of *D. somavarpatana*, *D. scandens*, *D. elegans*, *D. modesta*, and *D. paradoxa*, respectively.

*Fig.* 2 A, B, C, D, and E are the spermathecal apparatus of the species in the same order as in fig. 1. The atrial pouch in fig. D is contained in the septal wall 7/8. The pouches are cleared in acetic acid, so as to show the nature of the internal cavity.

*Fig.* 3 *a*, *b*, *c* represent the dissections of *D. somavarpatana*, *D. scandens*, and *D. paradoxa*. The septal deflections in the genital somites are a marked feature.

### Plate XVI.

*Fig.* 4. The left half of two somites' length of alimentary canal of young *D. paradoxa*. The anterior division shows the development of an enteric appendage and the second half contains a fully-developed appendage. A few of the multiplying cells have migrated to the tips of the muscle-fibres. The reflected membrane on the base of the appendage in the second half of the figure is the outer connective-tissue wall of the dorsal vessel.

*Fig.* 5. An entire nephridium of *D. paradoxa*: at points *a*, *b*, and *c* the structure of the vesicle and the different lobes is indicated in optical section.

*Fig.* 5 *a*. An entire nephrostome of *D. somavarpatana*, examined in glycerine. The secondary funnel is provided with stiff cilia.

*Fig.* 6. Transverse section of the nerve-cord of *D. somavarpatana*.

*Fig.* 6 *a*. A length of one-half of the nerve-cord of the same species, washed in silver nitrate and stained in methylin-blue, illustrating the mode of dendritic connections. Each nerve is composed of 8 to 10 fibres, of which only two are shown in the figure. The relative positions of the different nerve-cells and their dendritic connections have been drawn through Spencer Lens camera lucida. × 75.

### Plate XVII.

*Fig.* 7. Vertical section of skin of *D. somavarpatana* through the seta-follicle, showing the group of tall sensory cells which form the white papillæ round the seta (*ab*).

*Fig.* 8. Vertical section through prostomium of *D. somavarpatana*, showing groups of two kinds of sensory cells. The nerve-fibres in both preparations have been picked up by methylin-blue.

*Fig.* 9. Vertical section of skin of *D. scandens.*

*Fig.* 10. Transverse section of the egg-sac of *D. somavarpatana.*

*Fig.* 10 *a.* A teased preparation of the spherical testicular vesicle of *D. somavarpatana.*

*Fig.* 10 *b.* Transverse section of the tubular testicular sac of *D. somavarpatana.*

### Plate XVIII.

*Fig.* 10 *c.* Vertical section of the double testicular sac of *D. scandens*, showing their attachment to the septum 9/10.

*Fig.* 10 *d.* A sectional preparation of the ampulla of *D. elegans.*

*Fig.* 10 *e.* An entire ampulla of *D. scandens,* cleared and stained (hæmatoxylin).

*Fig.* 10 *f.* Transverse (a portion) section of the ectal end of the atrial pouch of *D. somavarpatana.*

*Fig.* 10 *g.* Section across the ental end of the same.

*Figs.* 10 *h*, 10 *i.* Section (a portion) across the atrial pouches of an adult and a young *D. paradoxa*; in the latter the ridge appears as a tube, the canal of which is obliterated in the former.

*Fig.* 10 *j.* A portion of the transverse section of the prostate of *D. somavarpatana* at the ectal end.

### *Lettering.*

*amp.*, ampulla; *amp.c.*, ampulliform mucous cells; *a.s.*, albumin space; *at.*, arterial twig; *b.t.*, basement-tissue; *b.v.*, blood-vessel; *c.c.*, cœlomo- and hæmocytes; *c.c.'*, central cell; *c.ep.* and *c.mes.*, cœlomic epithelium; *c.g.*, cutaneous gland; *c.m.*, circular muscle-fibres; *c.m.'*, membranous capsule; *c.p.* and *cut.*, cuticular layer; *ch.ov.*, ovarian chamber; *ch.*, chitinous layer; *ch.'*, chromation fibres; *cop.p.*, copulatory pouch; *cor.*, cortical layer; *d.*, dendrites; *d.p.*, dorsal pore; *d.v.*, dorsal vessel; *e.s.*, egg-sac; *em.*, epithelial membrane; *en.a.*, enteric appendage; *ep.c.*, epithelial cells; *f.*, funnel; *f.'*, fibrillæ; *f.c.*, filiform cells (associated with the sense of movement); *f.o.*, female opening; *f.t.*, funnel-tube; *g.mus.*, genital muscle; *giz.*, gizzard; *g.f.*, giant fibres; *gl.c.*, club-shaped cells; *gl.ep.*, glandular epithelium; *gr.* and *gr.m.*, granules and granular matrix; *i.c.*, undifferentiated cells; *in.*, intestinal wall; *in.l.*, inner looped lobe; *h.s.*, hayaline space; *l.m.*, lining membrane of seta-follicle; *l.t.l.*, longer twisted lobe; *m.* and *m.f.*, muscles; *m.c.*, marginal cell; *mg.f.*, marginal nerve-fibres; *m.i.*, muscles of the intestine; *ml.*, layer of megacytes (trophocytes); *m.m.*, metamorphosing muscles arranged like the ribs of a fan; *m.o.*, male opening; *m.t.*, muscular tube; *mt.c.*, motor cells; *m.w.*, mesenterial wall; *n.*, nuclei of syncytial cells; *n.c.*, nucleolus; *n.p.*, nucleoplasm; *ol.*, incipient trophocytes; *op.c.g.*, opening of cutaneous gland; *otl.*, outer looped lobe; *ov.*, ova and ovary; *ovd.*, oviduct; *out.ep.*, outer epithelial cells; *p.*, perceptory processes; *p.c.*, sensory processes of tactile cells; *p.c.'*, proliferating peritoneal cells; *p.c.''*, paired cells; *per.*, peritoneum; *pyr.c.*, pyramidal cells; *s.c.*, sensory cells; *s.d.g.*, spermiducal gland (prostate); *sep.*, septum 7/8; *sept.* and *sept.m.*, septal membrane; *s.f.*, secondary funnel; *s.f.'*, seta-follicle; *sh.*, connective-tissue sheath round the dorsal vessel; *s.o.*, spermathecal opening; *sp.b.*, sperm-blasts; *sp.c.*, spherical cells; *sp.d.*, spermiduct; *sp.m.*, sperm-morula; *sp.s.*, sperm-sac; *st.l.*, shorter twisted lobe; *t.b.*, tigroid bodies; *tc.*, testis-cells; *v.*, vesicle; *y.c.*, yolk-cells; *y.sp.*, yolk-platelets.

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## LI.—*Notes on the Species of* Notomys, *the Australian Jerboa-rats.* By OLDFIELD THOMAS.

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THE interesting jerboa-rats forming the genus *Notomys* have long been in a state of considerable confusion as regards the species that exist, or, rather, have existed; for it is to be feared that few of them still survive, except in the centre and north of the continent.

When Central Australia was being explored under the direction of Prof. Baldwin Spencer, a certain number of specimens were obtained, and Mr. Waite published some valuable notes on these *. He formed on them the groups *Podanomalus* and *Thylacomys* (which he afterwards renamed *Ascopharynx*); but, as I have elsewhere † shown, these names should be merged in the earlier *Notomys* of Lesson.

The throat-pouch described by Mr. Waite appears to be present in most if not all of the species, and would seem to be a skin-gland, such as many rodents, bats, and marsupials possess in a similar situation. Its use is probably of a sexually attractive nature, and I cannot at all accept the suggestion of Mr. Waite that the pouch might be of use for storing food, as is the case with the American Geomyidæ and the European Hamsters. Its structure and general appearance seem to me to preclude any such possibility.

The two main causes of the confusion that exists as to the species are, firstly, the publication by Gray of several names without descriptions, and, secondly, the fact that Gould, who had an excellent hunter's knowledge of the forms dealt with, knew nothing and gave no descriptions of the skulls, by which alone the species can be satisfactorily determined.

The following notes are based on a study of the series in the British Museum, which contains specimens obtained by

* P. Roy. Soc. Victoria, (2) x. pt. ii. p. 117 (1898).
† Ann. & Mag. Nat. Hist. (7) xvii. p. 83 (1906).